

Non-independent Occurrence of α_{s1} and β -Casein Variants of Cow's Milk

THE β -casein fraction of cow's milk has been found to show genetic variants distinguishable by electrophoresis¹. Part of the α_s -casein fraction, now called α_{s1} -casein (ref. 2), also shows genetic variation³. The α_{s1} -casein type *B* and the β -casein type *A* are prevalent, while the other two known variants of each only occur in some breeds of cattle^{4,5}. In Jersey cows α_{s1} -casein type *C* and β -casein type *B* are seen in a fair proportion of cases.

Examination of the results of typing one herd of British Jerseys suggested that the α_{s1} - and β -variants did not occur independently and this trend was confirmed by more numerous data for British and American Jerseys. The pooled results for all available cows (not a random sample of the breed) gave the following pattern of occurrence:

		<i>A</i>	β -casein		<i>B</i>
			<i>AB</i>	<i>AC</i>	
α_{s1} -casein	<i>B</i>	60	73	56	
	<i>BC</i>	45	82	—	
	<i>C</i>	35	—	—	

The joint distribution shows a complete absence of three combinations of types. Based on expectations derived from the marginal totals of the above table, the absence of these three classes is judged to be highly significant and extremely unlikely to be due to chance ($P < 0.00001$).

Pooled data for Guernsey cattle typed in Britain and the United States were arranged in the same manner.

		<i>A</i>	β -casein		<i>C</i>
			<i>AB</i>	<i>AC</i>	
α_{s1} -casein	<i>B</i>	85	5	11	1
	<i>BC</i>	52	2	5	—
	<i>C</i>	9	—	—	—

The absence of certain combinations is noticeable, although the expectation of observations in these classes is here small. A similar picture was found for American Brown Swiss cows:

		<i>A</i>	β -casein		<i>AC</i>
			<i>AB</i>	<i>B</i>	
α_{s1} -casein	<i>B</i>	146	69	4	2
	<i>BC</i>	22	5	—	—
	<i>C</i>	2	—	—	—

Here again the absence of some classes could easily be ascribed to chance, but the similarity to the other results suggests that this is not the explanation.

Evidence has been produced to show that both α_{s1} - and β -casein variants are inherited in a straightforward Mendelian manner^{1,3}. The loci have been designated

α_{s1} -Cn and β -Cn. The present finding that the two kinds of variants do not occur independently suggests that the two loci may be linked, and in the Jersey breed, for example, the following chromosomes would be postulated: α_{s1} -CnB, β -CnA; α_{s1} -CnB, β -CnB; and α_{s1} -CnC, β -CnA. Since the α_{s1} -CnB, β -CnA combination prevails in all breeds^{4,5} the other combinations are assumed to be the result of mutations in either α_{s1} -Cn or β -Cn. The combination of α_{s1} -CnC, β -CnB apparently does not occur, so the linkage would have to be very close unless recombinant types were at a selective disadvantage.

The non-independent occurrence of α_{s1} - and β -casein variants makes it desirable to examine segregating families in order to elucidate the mechanism involved. Such an investigation is difficult since the genotypes of bulls must be deduced, but the large families available as a result of artificial insemination should provide the necessary material.

If the suggestion of linkage between the α_{s1} - and β -casein loci is confirmed, then another case would be added to the growing number in which linkage between chemically related proteins has been found, for example, β - and δ -chain haemoglobin variants⁶ and egg-white proteins⁷.

Note added in proof. Close linkage has been confirmed by family studies independently carried out by Grosclaude, Garnier, Ribadeau-Dumas and Jeunet (*C. R. Acad. Sci., Paris*, 259, 1569; 1964).

J. W. B. KING

Agricultural Research Council,
Animal Breeding Research Organisation,
Edinburgh, 9.

R. ASCHAFFENBURG

National Institute for Research in Dairying,
Shinfield, Berkshire.

C. A. KIDDY

Dairy Cattle Research Branch,
Agricultural Research Service,
U.S. Department of Agriculture,
Beltsville, Maryland.

M. P. THOMPSON

Eastern Utilization Research and
Development Division,
Agricultural Research Service,
U.S. Department of Agriculture,
Philadelphia.

¹ Aschaffenburg, R., *Nature*, 192, 431 (1961).

² Thompson, M. P., and Kiddy, C. A., *J. Dairy Sci.*, 47, 626 (1964).

³ Thompson, M. P., Kiddy, C. A., Pepper, L., and Zittle, C. A., *Nature*, 195, 1001 (1962).

⁴ Kiddy, C. A., Thompson, M. P., Johnston, J. O., and Pepper, L., *J. Dairy Sci.*, 46, 626 (1963).

⁵ Aschaffenburg, R., *J. Dairy Res.*, 30, 251 (1963).

⁶ Boyer, S. H., Rucknagel, D. L., Weatherall, D. J., and Watson-Williams, E. J., *Amer. J. Hum. Genet.*, 15, 433 (1963).

⁷ Buvarandran, V., *Genet. Res.*, 5, 330 (1964).